July 22, 1969 C. D. CUPP 3,456,642

DEMAND ACTUATING MEANS FOR ALTERNATE BREATHING SUPPLY

Filed Dec. 27, 1966 3 Sheets-Sheet 1

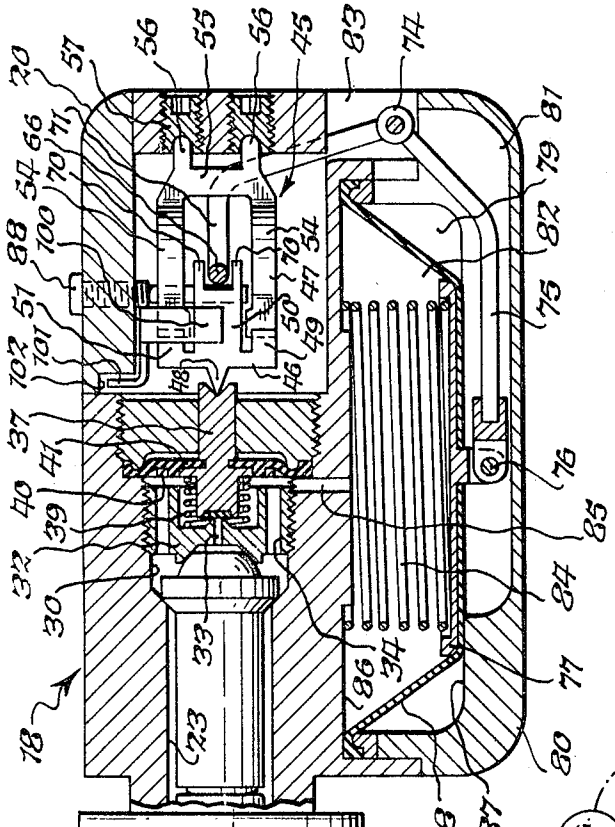


Fig. 2.

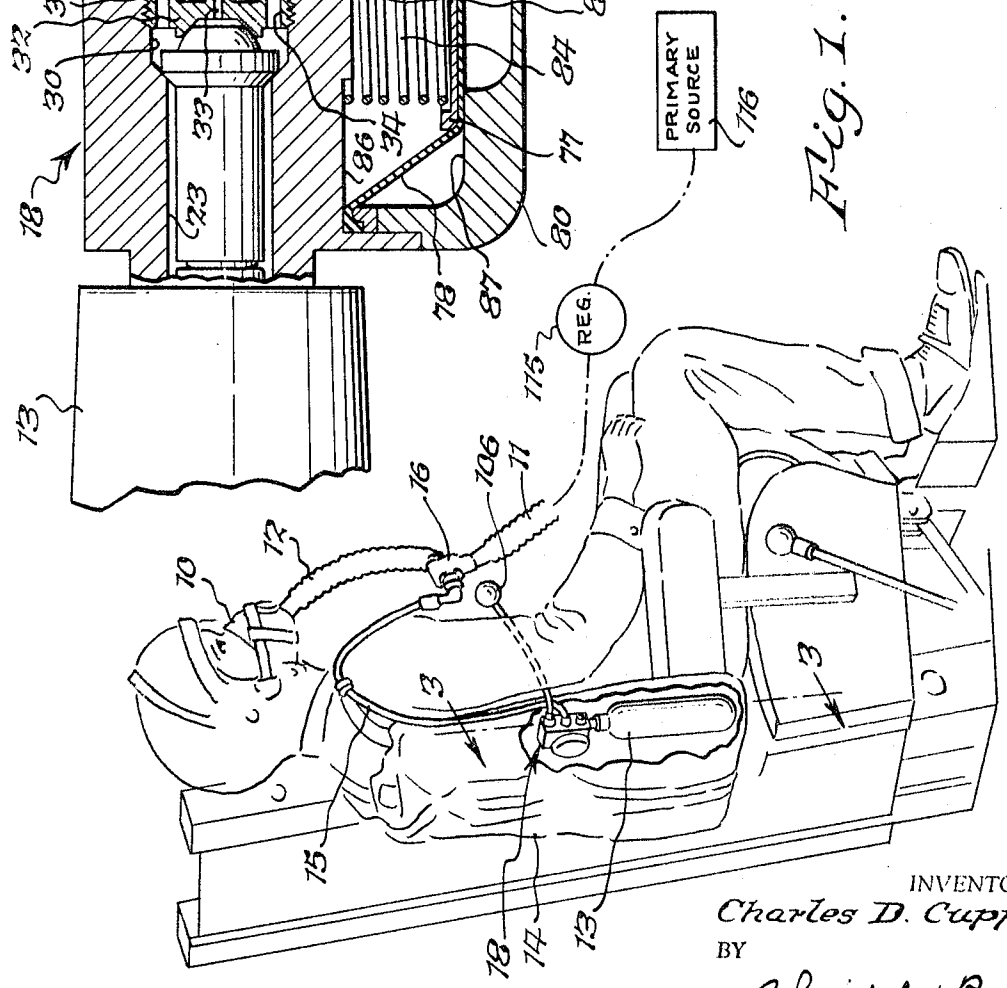


Fig. 1.

INVENTOR.
Charles D. Cupp
BY
Christel & Bean
ATTORNEYS.

July 22, 1969 C. D. CUPP 3,456,642

DEMAND ACTUATING MEANS FOR ALTERNATE BREATHING SUPPLY

Filed Dec. 27, 1966 3 Sheets-Sheet 2

Fig. 3.

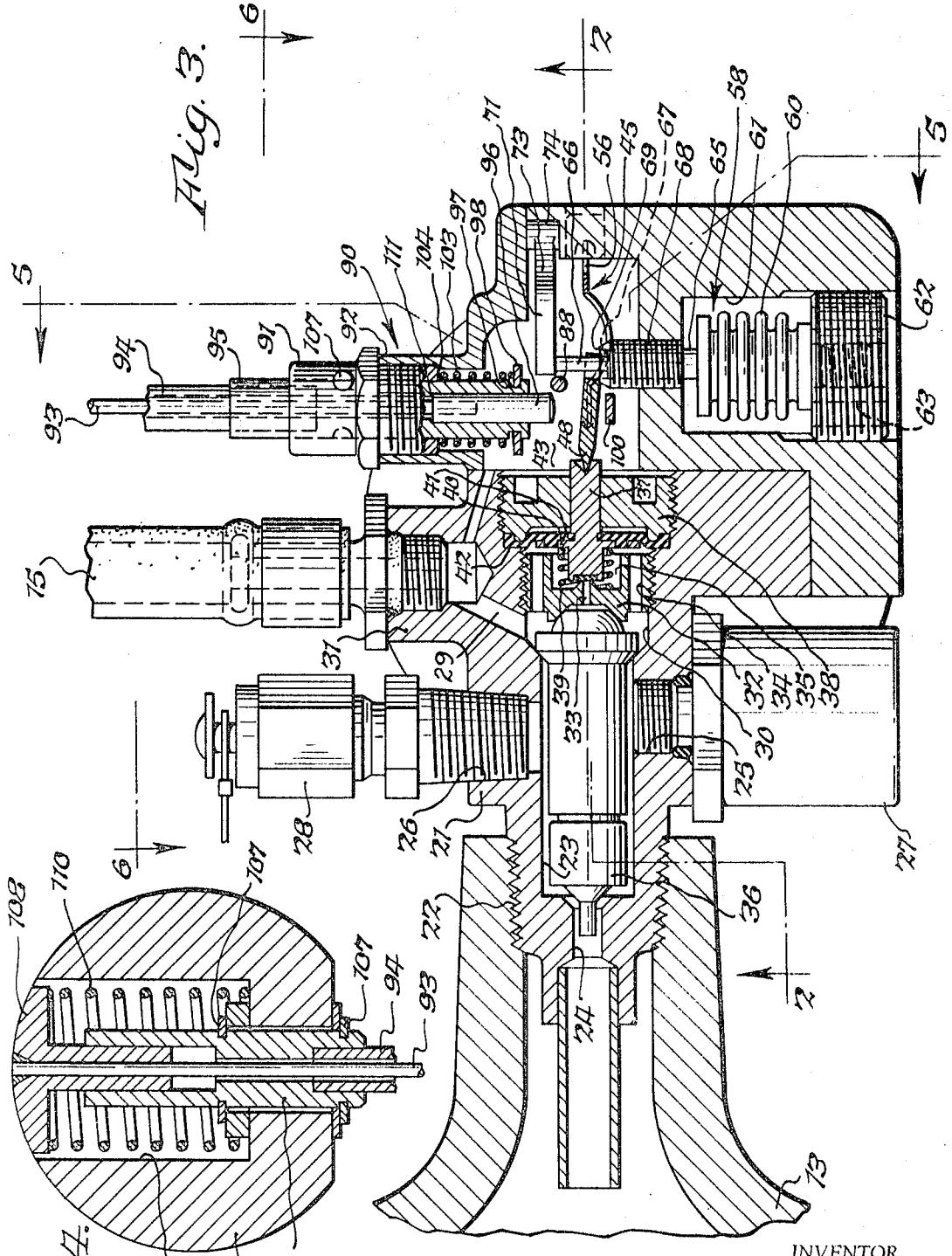


Fig. 4.

INVENTOR.
Charles D. Cupp
BY
Christel & Bean
ATTORNEYS.

July 22, 1969 C. D. CUPP 3,456,642

DEMAND ACTUATING MEANS FOR ALTERNATE BREATHING SUPPLY

Filed Dec. 27, 1966 3 Sheets-Sheet 3

Fig. 6.

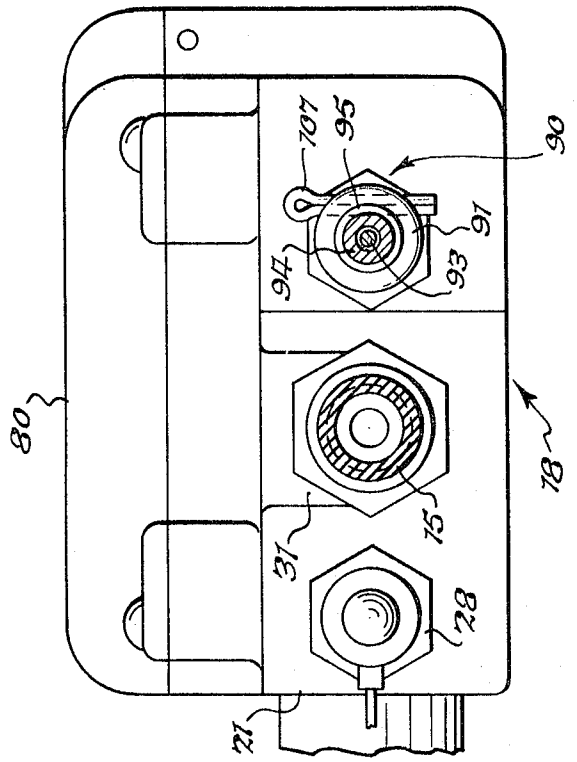
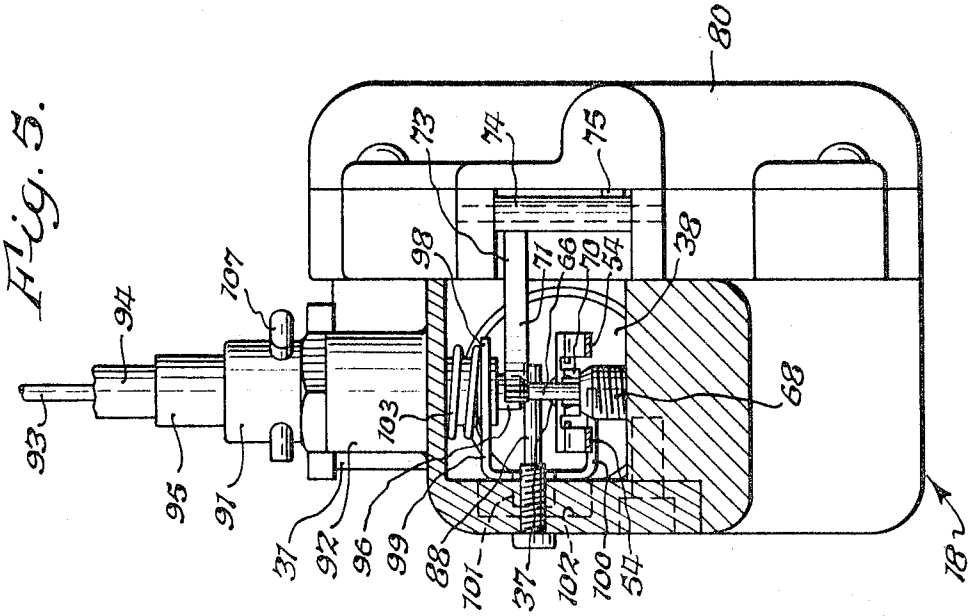


Fig. 5.



INVENTOR.
Charles D. Cupp
BY
Christel & Bean
ATTORNEYS.

United States Patent Office 3,456,642
Patented July 22, 1969

3,456,642

DEMAND ACTUATING MEANS FOR ALTERNATE BREATHING SUPPLY

Charles D. Cupp, Lancaster, N.Y., assignor, by mesne assignments, to "Automatic" Sprinkler Corporation of America, Cleveland, Ohio, a corporation of Ohio

Filed Dec. 27, 1966, Ser. No. 604,979
Int. Cl. A62b 7/04
U.S. Cl. 128—142.2 8 Claims

ABSTRACT OF THE DISCLOSURE

The user is supplied with breathing fluid from a first source during normal inspiration. The inspiration effort made by the user is sensed by a control which supplies the user with breathing fluid from a normally closed second source automatically in response to an abnormally strong inspiration effort. The control includes an aneroid for turning on the second source automatically only when the ambient atmospheric pressure is below a predetermined level. A manually operable arrangement can actuate and reset the control.

BRIEF SUMMARY OF THE INVENTION

The present invention relates generally to multi-source systems supplying breathing fluid to a user. More specifically, the present invention relates to an actuator in an oxygen supply system providing oxygen to the wearer of a face mask from a main oxygen source during normal inspiration, the actuator herein described being operable positively and automatically in response to an abnormally strong inspiration effort to establish communication with an auxiliary source of oxygen.

In single source oxygen systems unexpected depletion of the oxygen source or interruption of the flow of oxygen can result in serious injury or death to a user thereof in toxic, high altitude or other oxygen deficient environments. Systems having primary and secondary sources are customarily used to avoid this difficulty and usually provide manually controlled means to switch from the primary to the secondary source. However, the user sometimes is unable to manually switch to his auxiliary source, and may not even be aware that his main source is depleted or that the flow therefrom is interrupted. A pilot, for example, may be unconscious or injured and unable to manually switch from the main oxygen source carried in his aircraft to the portable auxiliary source carried on his person upon ejection from the craft. Automatic actuators have been proposed, but so far as I am aware they are not directly responsive only to actual demand of the user for more oxygen. A primary object of my invention is to provide an oxygen supply system having a primary source normally providing oxygen to the user with means automatically establishing communication with an auxiliary source of oxygen in response to an abnormally strong inspiration effort by the user. The natural, involuntary reaction of a pilot or any user of an oxygen system upon interruption, insufficiency or depletion of the oxygen supply is an abnormal, convulsive inspiration effort in the form of a gasp.

The actuating means of this invention distinguish between such an abnormal inspiration effort and normal breathing efforts and are operable only in response to the former. The auxiliary source therefore is turned on only upon actual need by the user.

In certain instances, however, it is unnecessary and undesirable to automatically establish communication between the face mask and an auxiliary source of oxygen upon interruption or depletion of the main source. Environmental conditions may make the establishment and consequent depletion of such secondary source unnecessary as, for example, when a pilot ejects from his aircraft at an altitude sufficiently low as not to require supplemental oxygen or when testing the apparatus at ground level.

Accordingly, it is another object of my invention to provide an actuator having the foregoing characteristics and which is operable only in predetermined environmental conditions.

A further object of my invention is to provide an actuator having the foregoing characteristics and which can be manually actuated and reset for testing purposes.

In one aspect thereof, the present invention is characterized by the provision, in combination with first and second fluid supply means, a face mask, and means including a conduit normally providing breathing fluid to the wearer of the face mask from the first supply, of pressure sensitive means communicating with said conduit and operable responsive to an abnormal inspiration effort to establish communication between the second supply and the face mask.

Various other novel features of construction and advantages inherent in the actuator construction of the present invention are pointed out in the following detailed description of an illustrative embodiment thereof considered in conjunction with the accompanying drawings depicting the same wherein like numerals represent like parts throughout the various views.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a perspective view of a pilot shown using a multi-source oxygen system with portions of his ejection seat and survival equipment cut away to illustrate the actuator of the present invention and an auxiliary oxygen source;

FIG. 2 is a fragmentary cross sectional view of the actuator of the present invention taken about on line 2—2 of FIG. 3;

FIG. 3 is a fragmentary cross sectional view thereof taken about on line 3—3 of FIG. 1;

FIG. 4 is a fragmentary cross sectional view of a handle used in the actuator thereof;

FIG. 5 is a fragmentary cross sectional view of the actuator of the present invention taken about on line 5—5 of FIG. 3; and

FIG. 6 is a fragmentary view thereof taken about on line 6—6 of FIG. 3.

DETAILED DESCRIPTION

Referring now to the accompanying drawings, FIG. 1 shows a pilot wearing a face mask **10** supplied with oxygen from a main oxygen supply source fixed in the aircraft (both of which are well known in the art and therefore not shown) through conduits including a main hose **11** and a feeder hose **12**. In the illustrated form, the pilot carries a secondary or auxiliary oxygen source comprising a tank **13** secured in parachute pack **14** and having a connecting conduit **15** communicating with feeder hose **12** through a Y connector **16** which includes a check valve (not shown) to prevent the escape of oxygen from reserve tank **13** through main hose **11**. Tank **13** can be a conventional bottle or cylinder of oxygen under relatively high pressure.

Auxiliary tank **13** is capped by the inspiration responsive actuator of the present invention, generally designated **18**, which includes a housing **20** having a base portion **21** with an externally threaded base **22** for connection to reserve tank **13**. A bore **23** extends through base portion **21** having at one end a reduced axial passage **24** opening into auxiliary tank **13**. A pair of lateral passages **25** and **26** open into bore **23** and respectively communicate with

a pressure gage 27, for measuring and indicating the pressure in tank 13, and a charging fitting 28 for filling the same. An inclined passage 29 communicates between an enlarged portion 30 adjacent the other end of bore 23 and a lateral nipple 31 adapted for connection to hose line 15.

A seat member 32 threads into the enlarged bore portion 30 and comprises an axial port 33, a plurality of circumferentially spaced openings 34 therearound communicating between opposite sides of seat member 32 and a cylindrical recess 35 opening through the face thereof away from tank 13. A flow controller 36, of known construction, is disposed in bore 23 and oxygen flows from tank 13 through passage 24 and through controller 36, port 33 (when open) and into recess 35.

Under normal conditions, port 33 is sealed by a poppet valve 37 which is axially slidable in a retainer 38 threaded in a further enlarged extension of bore 23 to abut and seat against port 33 within recess 35. A tension spring 39 engages the base of recess 35 and a radial flange 40 on valve 37 and biases valve 37 to an open position. A diaphragm 41, secured behind flange 40 and peripherally sealed between retainer 38 and a shoulder 42 on housing 20, seals bore 24 from a cavity 43 in housing 20 containing a toggle mechanism generally designated 45.

Toggle mechanism 45 normally maintains valve 37 seated against port 33 by preventing axial displacement of valve 37 under the opening bias of spring 39. Toggle mechanism 45 includes a bearing member 46 (FIG. 2) and a toggle spring 47, the bearing member 46 including a pointed element 48 engaging in a cone-shaped recess on the outer end of valve 37 and spaced tines 49, 50 and 51. Spring 47 includes a pair of bowed leaf members 54 joined at one end by a cross member 55 having nubs 56 abutting tension adjusting set screws 57 threaded through housing 20. The opposite ends of leaf members 54 have knife edges engaging in V-shaped grooves on the ends of tines 49 and 51. Middle tine 50 extends into the path of a toggle operator generally designated 58.

Toggle operator 58 includes an aneroid 60 positioned in an outwardly opening chamber 61 formed in housing 20. A bellows-type aneroid is illustrated but it will be understood that other types of aneroids and pressure responsive mechanisms may be utilized without departing from the scope of the present invention. A cap screw 62 having circumferentially spaced openings 63 communicating between the ambient atmosphere and chamber 61 threads in the outer end of chamber 61. Aneroid 60 is fixed at one end to the inner face of capscrew 62 and is free to axially flex inwardly in chamber 61. The other end of aneorid 60 carries a plunger 65 having a reduced diameter stem 66 at one end defining a shoulder 67.

Plunger 65 slides in a sleeve 68 sealing chamber 61 from cavity 43 with the inner end of sleeve 68 providing a stop 69 on one side of the toggle mechanism 45. Plunger 65 extends to a point adjacent middle tine 50 with stem 66 extending through a pair of lateral end projections 70 on middle tine 50 (FIG. 2) and between leaf members 54 to abut the end of a leg 71 of a U-shaped stop member 72. Stop member 72 has a base portion 73 (FIG. 2) pivoted at 74 to housing 20 with the end of its other leg 75 pivoted at 76 to a pressure plate 77 engaging behind a diaphragm 78. The arrangement of pivot 74 and 76 permits the end of leg 71 to swing laterally from abutting relationship with stem 66 in response to inward movement of diaphragm 78.

Diaphragm 78 is disposed in a lateral cavity 79 (FIG. 2) formed on the side of housing 20 and enclosed by an outer casing 80. Diaphragm 78 partitions cavity 79 into chambers 81 and 82. Chamber 81 is open to atmosphere via an opening 83 through housing 20 adjacent pivot 74. Chamber 82 is closed to atmosphere and communicates with enlarged bore portion 30 through duct 85 whereby pressure in chamber 82 reflects the inspiration effort of the wearer of face mask 10 via duct 85, openings 34, inclined passage 29, nipple 31, line 15, Y connector 16 and feeder hose 12. A spring 84 engages the inner face of pressure plate 77 and a shoulder 86 in chamber 82 and normally maintains diaphragm 78 against a shoulder 87 on casing 80 during normal inspiration.

Under normal conditions, the oxygen user, a pilot in the illustrated form, will draw oxygen from the fixed primary source of the craft (not shown) through main hose 11 and feeder hose 12 to face mask 10, under control of the usual demand regulator, indicated at 115 and located between connector 16 and the primary source, indicated at 116. The suctive effect of each inspiration effort therefore is communicated to chamber 82, and reduces the pressure therein. However, the increased pressure differential on diaphragm 78 resulting from a normal breathing effort is insufficient to overcome the bias of spring 84, which is selected to resist all but a truly abnormally strong inspiration effort. Therefore, with a normal breathing effort valve 37 remains closed. However, if the pilot's primary source 116 fails or is cut off, as for example upon ejection from the aircraft, his natural reaction to the absence of sufficient oxygen during his next inspiration will be to gasp and make an abnormally strong inspiration effort. This will radically lower the pressure in chamber 82 and the resulting pressure differential will be sufficient to move diaphgram 78 inwardly against the bias of spring 84. The end leg 75 follows the inward movement of diaphragm 78 to pivot stop member 72 and swing the end of leg 71 out of interfering relation with stem 66. Aneroid 60 is thereby freed to expand and engage end shoulder 67 of plunger 65 with middle tine 50 of toggle mechanism 45 to carry the same past center, against the bias of spring 47 into engagement against a stop 88, thereby releasing valve 37. Spring 39 urges poppet valve 37 open to permit oxygen in reserve tank 13 to flow through controller 36, port 33, recess 35, openings 34, passage 29, hose 15 and into face mask 10. However, this will occur only at or above a predetermined altitude, providing sufficient pressure differential on aneroid 60 to produce the foregoing expansion movement thereof.

It is thus apparent that actuator 18 establishes communication between face mask 10 and auxiliary oxygen supply 13 only in response to an abnormal inspiration effort, reflecting an actual demand for oxygen, and then only when the ambient atmospheric pressure is below a predetermined level, as would exist at altitudes above 9,000 feet. If an abnormal inspiration effort is made at a low altitude, not requiring the use of auxiliary oxygen, aneroid 50 would not expand axially sufficiently to engage and move toggle mechanism 45 over center to release the reserve oxygen to face mask 10.

Since actuator 18 is designed not to operate automatically below a predetermined altitude, a manual actuating device and reset generally designated 90 is provided to test the toggle mechanism 45 and the availability of reserve oxygen to face mask 10 upon actuation of toggle mechanism 45. It also provides an emergency release operable independently of the automatic inspiration responsive mechanism in the event of malfunction of the latter.

Manual actuator 90 includes a tubular adaptor 91 threaded in a nipple 92 formed on housing 20, and inner and outer coaxial probe elements 93 and 94 axially slidable relative to each other. Probe elements 93 and 94 are preferably flexible cables with cable 94 having a rigid sleeve 95 on its end and slidable in adaptor 91 and with cable 93 having a plunger 96 fixed on its end and slidable within sleeve 95. Sleeve 95 projects within housing 20 opposite middle tine 50 of toggle 45 and has a pair of notches 97 receiving bifurcated leg portions 98 of a generally U-shaped slide 99 (FIG. 5) with the other leg 100 thereof disposed behind middle tine 50. A tab 101 projects laterally from the base of U-shaped slide 99 and engages in a slot 102 formed on the inner face of housing 20 to prevent rotation of slide 99 in cavity

43. To maintain slide **99** spaced about toggle **45** and in a non-interfering position during normal operation, a spring **103** encircles the inner end of sleeve **95** and engages between a shoulder **104** on adaptor **91** and slide leg portions **98** to urge sleeve **95** and slide **99** inwardly.

The other end of probe **94** is suitably anchored in a retaining sleeve **105** (FIG. 4) secured within a handle **106** by retaining rings **107**. To manually actuate toggle **45** handle **106** is pulled retracting sleeve **95** against the bias of spring **103** and causing leg **100** of slide **99** to engage behind middle tine **50** and carry toggle **45** over center, thereby releasing valve **37** and opening port **33** to permit oxygen from auxiliary tank **13** to flow to face mask **10**. To prevent inadvertent manual actuation of actuator **18** a cotter pin **107** engages through and interlocks adaptor **91** and sleeve **95** to prevent sleeve **95** from sliding in adaptor **95**. Pin **107** must be removed prior to manual actuation.

To restore toggle **45** to its previous position, shown in the drawings, and thereby reset the actuator, the outer end of inner probe **93** passes through retaining sleeve **105** in handle **106** and is secured to a reset button **108** carried in a recess **109** in handle **106**. Button **108** telescopes in retaining sleeve **105** and is biased outwardly by a spring **110** engaging between the underside of button **108** and the base of recess **109**. Plunger **96** at the opposite end of probe **93** engages against a shoulder **111** on sleeve **95** to limit such outward movement of probe **93** and button **108**. Depression of button **108** causes plunger **96** to engage middle tine **50** and push toggle **45** back to the normal over center locking position shown in FIG. 3.

Thus, it will be appreciated that the present invention fully accomplishes its intended objects by providing an automatic turn-on for multi-source oxygen systems which reacts instantly to abnormally strong inspiration effort to restore oxygen flow after one source has aborted. By utilizing the inspiration effort of the oxygen user to trigger the actuator, automatic operation, at the instant a lack of oxygen occurs, is insured. While designed primarily for automatic operation at relatively high altitudes, it is readily apparent that the actuator of the present invention can be operated at any desired altitude by changing aneroid **58** to respond to different pressures. Manual actuating device **90** provides a means to test the auxiliary oxygen system and an emergency means for establishing communication between the auxiliary oxygen supply and face mask **10**.

While the breathing fluid has been referred to herein as oxygen, it is obvious that the invention is usable with breathing fluids of any mixture. Having thus described and illustrated a preferred form of the actuator construction invention, it will be understood that such description and illustration is by way of example only and that such modifications and changes as may suggest themselves to those skilled in the art are intended to fall within the scope of the present invention which is limited only by the appended claims.

What I claim is:

1. In a breathing fluid supply system, a face mask, conduit means connected to said mask and adapted for connection to a first source of breathing fluid for providing fluid to the wearer of said face mask from such first source during normal inspiration, a second source of breathing fluid, and actuating means including pressure sensitive means communicating with said conduit means operable automatically in response to an abnormally strong inspiration effort by a wearer of said mask to establish communication between said second source and said face mask.

2. A breathing system according to claim **1** together with a valve normally interrupting communication between said mask and said second source, valve control means including a valve operator movable between valve opening and closing positions, and means responsive to a predetermined pressure to move said valve operator to its valve opening position, said pressure sensitive means being operable during normal inspiration to prevent said valve from opening.

3. A breathing system according to claim **2** wherein said valve operator comprises a spring biased toggle, said predetermined pressure reponsive means being operable to engage said toggle and move the same overcenter to open said valve, said pressure sensitive means disabling said predetermined pressure responsive means during normal inspiration to prevent opening of said valve.

4. A breathing system according to claim **2** wherein said predetermined pressure responsive means comprises an aneroid.

5. A breathing system according to claim **2** including manually operable means movable to engage said valve operator and move the latter to said valve opening position, said manual means including valve reset means movable to engage said valve operator and move the latter to said valve closing position.

6. A breathing system according to claim **3**, together with coaxial members slidable relative to one another, one of said members being adapted to engage and move said toggle to said valve opening position, the other of said members being adapted to engage and move said toggle to said valve closing position, and manual means operable to slide said members independently of one another.

7. A breathing system according to claim **3** wherein said predetermined pressure responsive means includes a stem movable to engage said toggle, said pressure sensitive means including a chamber closed by a diaphragm and communicating with said face mask, a locking member normally engaging said stem to restrain the same from movement, said locking member being movable to release said stem in response to movement of said diaphragm into said chamber, and means yieldably restraining said diaphragm against such movement.

8. A breathing system according to claim **1** connected to the breathing fluid supply system of a vehicle as the first source, wherein said second source comprises a tank of compressed breathing fluid carried by the wearer of said mask.

References Cited

UNITED STATES PATENTS

2,329,289	9/1943	Morehouse	128—142
2,824,557	2/1958	Mejean et al.	128—142

FOREIGN PATENTS

907,390	10/1962	Great Britain.

LAWRENCE W. TRAPP, Primary Examiner